UNITED STATES PATENT APPLICATION

FOR

EVAPORATIVE EMISSION SYSTEM INTEGRITY MODULE

INVENTOR:

Darrin W. Hurley

PREPARED BY:

DaimlerChrysler Intellectual Capital Corporation
800 Chrysler Drive East
CIMS 483-02-19
Auburn Hills, MI 48326-2757

EVAPORATIVE EMISSION SYSTEM INTEGRITY MODULE

CROSS REFERENCE TO RELATED APPLICATION(S)

This application claims the benefit of U.S. Provisional Application No. 60/503,394 filed September 16, 2003.

FIELD OF THE INVENTION

The present invention relates generally to evaporative emission control for a motor vehicle, and, more particularly, to an improved leak detection and control arrangement for an evaporative emission system of a motor vehicle.

BACKGROUND OF THE INVENTION

In a conventional evaporative emission system, an emission control device is utilized to recover fuel vapor in a charcoal canister from a refueling event and selectively purge this fuel vapor from the charcoal canister into the engine. The emission control device is further utilized to perform leak detection tests to verify the integrity of the evaporative emission system and also provide pressure relief of the evaporative emission system. The emission control device is typically connected to an engine and a fuel tank and also includes a connection to the atmosphere. In general, conventional emission control devices provide control of various valves under specific engine operating

conditions to perform system leak tests as well as system pressure relief. An example of such an evaporative emission system is disclosed in commonly owned U.S. Patent No. 6,073,487 which is hereby incorporated by reference.

While such conventional systems work for their intended purpose, packaging of numerous system components and solenoids undesirably increase complexity and cost as well as typically require calibration for effective operation. Thus, there is a need for an evaporative emission system that overcomes the aforementioned and other disadvantages.

SUMMARY OF THE INVENTION

Accordingly, an evaporative emission control and leak detection system for a motor vehicle is provided. The system is in fluid communication with a fuel tank, an engine, and a carbon canister. The system includes an integrated valve module that is connected to the carbon canister and is in fluid communication with the atmosphere. The module is arranged to vent the system when exposed to predetermined high negative and positive pressure conditions, and a predetermined low negative pressure condition. The module includes a switch mechanism that is operable to indicate when the system is in a high or low negative pressure condition.

In accordance with another aspect of the present invention, the system can further include a low pressure valve and a high pressure valve with the valves being coupled in parallel to a fluid passage between the carbon canister and the atmosphere. The low

pressure valve is arranged to provide low negative pressure system relief. The high pressure valve is a two-way valve arranged to provide both high positive and negative pressure system relief.

BREIF DESCRIPTION OF THE DRAWINGS

Other aspects, features, and advantages of the present invention will become more fully apparent from the following detailed description of the preferred embodiment, the appended claims, and in the accompanying drawings in which:

Figure 1 illustrates a cross sectional view of an exemplary embodiment of an integrity module in accordance with the present invention;

Figure 2 illustrates a cross sectional view of an exemplary embodiment under a low vacuum relief condition in accordance with the present invention;

Figure 3 illustrates a cross sectional view of an exemplary embodiment under a high vacuum relief condition in accordance with the present invention; and

Figure 4 illustrates a cross sectional view of an exemplary embodiment under a pressure relief and/or refueling bypass condition in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMIENT

Referring now to the drawings, Figure 1 illustrates a cross section of an exemplary embodiment of the emission control module 5. In accordance with one aspect of the present invention, a switch mechanism 10 is provided for performing low level vacuum leak detection testing when the vehicle is not in operation. The switch mechanism 10 comprises a one-way check valve 20 and a biased-open low vacuum switching element 30, such as a spring-loaded diaphragm illustrated in Figure 1, arranged to engage an electrical connector 40.

In operation and referring to Figure 2, the check valve 20 is arranged to open at a predetermined low vacuum condition threshold, thereby exposing a chamber 50 containing the low vacuum switch element 30 to a low vacuum condition that was generated by vehicle operation. The biasing of the low vacuum switch element 30 is arranged to be overcome at a vacuum threshold lower than the threshold of check valve 20 such that upon exposure to the low vacuum condition, the low vacuum switch element 30 will engage the electrical connector 40 and thereby complete a circuit for low level leak test verification. The pattern of fluid flow for low vacuum relief and low vacuum leak test verification is illustrated by arrows A in Figure 2.

In accordance with another aspect of the present invention, the emission control apparatus further includes a high pressure valve element 60 positioned relative to an

atmospheric port 70 and arranged in conjunction with the low vacuum switch element 30 to allow for high vacuum leak detection testing. The high pressure valve element 60 includes a high negative pressure check valve member 80 and a gravity biased high positive pressure valve member 90. The high negative and positive pressure valve members translate along a common axis 100 and are arranged to provide high positive and negative system pressure relief as well as high vacuum leak detection system verification.

In operation and referring to Figure 3, when a high vacuum leak test is desired to be performed, an engine purge valve (not shown) is operated to close a connection between the emission control apparatus 5 and an engine (not shown) to create a high vacuum condition in the evaporative emission system. Initially, when the high vacuum condition is above a predetermined high vacuum threshold, both valve member 80 and valve 20 are in an open position. Subsequently operating the purge valve to stop the vacuum draw thereby allows the high vacuum condition to start to bleed down. Stopping the vacuum draw causes the amount of vacuum to drop below the threshold of the high vacuum threshold of valve member 80 and thus allowing for it to close. As the vacuum bleeds down to a level below the low vacuum threshold, the low vacuum check valve 20 will likewise close and the low vacuum switch element 30 is arranged to disengage from the electrical connector 40 and open the circuit. The rate at which the vacuum bleeds down from the high vacuum threshold to a level that opens the circuit is measured and

compared to a calibrated value for high vacuum leak test verification. Fluid flow distribution for the high vacuum leak test verification is shown by arrows B in Figure 3.

In accordance with another aspect of the present invention and referring to Figure 4, the high pressure valve element 60 is operably connected to a carbon canister (not shown) at a canister interface port 110 and is arranged to provide pressure relief and refueling bypass, canister purging, and vacuum relief and regulation if engine vacuum exceeds the predetermined high vacuum threshold. It should be appreciated that the carbon canister can be connected to the integrity module through a fluid communication or a coupling arrangement at carbon canister interface port 110. For positive pressure relief and refueling bypass, the high pressure valve element 60 is arranged to translate along common axis 100 as a single unit and lift sealing member 120 off of seal seat 130 when a high positive pressure condition greater than a high predetermined positive pressure threshold is present. This allows for pressure relief and refueling bypass relief with a fluid flow pattern as shown by arrows C in Figure 4. Figure 3 also illustrates a fluid flow pattern through emission control module 5 for high vacuum system relief and carbon canister purging through carbon canister port 110.

Incorporation of vacuum relief capability into the emission control apparatus provides for elimination of a separate, remotely located solenoid valve typically used in conventional evaporative emission control systems. In addition, by providing a low vacuum switch element having a check valve in accordance with this invention, the need

for calibration on the switch element is obviated. More specifically, when the low vacuum condition is present in the system, the low vacuum check valve opens allowing the vacuum into a chamber containing the low vacuum switch element and the electrical connector. Before the low vacuum check valve opens, the pressure in this chamber is atmospheric. In the exemplary embodiment, the low vacuum switch element is biased open with a light spring and requires very little pressure to actuate (less than the low level vacuum check valve threshold), thus eliminating a need to calibrate the spring. These components are spatially separated and combined in a module in the emission control apparatus allowing for a more efficient packaging arrangement.

The foregoing description constitutes the embodiments devised by the inventors for practicing the invention. It is apparent, however, that the invention is susceptible to modification, variation, and change that will become obvious to those skilled in the art. Inasmuch as the foregoing description is intended to enable one skilled in the pertinent art to practice the invention, it should not be construed to be limited thereby but should be construed to include such aforementioned obvious variations and be limited only by the proper scope or fair meaning of the accompanying claims.